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Ultrasonographic Evaluation and Differentiation of Tumorous Lesions in the Floor of the Mouth: Case Reports and a Review of the Literature

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Abstract: Ultrasonography may provide some information as to the tissue characteristics of tumorous lesions in the floor of the mouth, which have not been sufficiently clarified. Ultrasonographic imaging characteristics of these lesions are presented and the differential diagnoses are discussed. Ultrasonographic images of 5 patients with metastatic lingual lymph nodes (squamous cell carcinoma), lymphangioma, Schwannoma, ranula and dermoid cyst are presented. The literature on the imaging features of tumorous lesions in the floor of the mouth was searched using Medline. Five cases of tumorous lesions in the floor of the mouth are presented. The differential diagnosis through a review of the references was discussed. Ultrasonographic images clearly showed the internal structures of the mass. The homogeneity varied according to the degree of closeness of the cells and tissues, or the presence of fluid, hemorrhage, cystic degeneration and calculus. The echogenicity was due to the high acoustic impedance of calculus, cholesterol, and so on. The imaging features varied according to the ratio of the tissues, such as fat and fibrous tissue (in lipoma), or cholesterol and keratin (in dermoid cyst). A high vascular mass indicated malignant salivary gland tumors and hemangioma. In conclusion, ultrasonographic images revealed the distinctive features of the lesions and were useful for the differential diagnosis. Therefore, ultrasonography could be used to conjecture the content of the lesions and is considered to be useful for easy and accurate diagnosis prior to treatment.

Key words: ultrasonography, floor of mouth, tumor

Introduction

The floor of the mouth is a crescent-shaped area between the lower gingiva and the undersurface of the tongue, formed by the suprahyoid muscles[1]. This region includes the orifice and duct of the sublingual and submandibular glands and the hypoglossal and lingual nerves. Carcinomas with mucosal pathology (necrosis

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or exophytic growth) can only be easily diagnosed by physical examination, while the diagnosis of other tumorous lesions is usually accomplished by clinical examination and biopsy. However, there are some difficulties or limitations in performing excision or biopsy because of the anatomical characteristics in this region.

Possible tumorous lesions involving the floor of the mouth are malignant tumors, benign tumors and cysts[2–3]. The roles of the imaging modalities are to provide additional information as to the extent and tissue characterization of the lesions. The imaging also may indicate the most suitable point for performing a biopsy. Ultrasonography may be a simple alternative modality that can noninvasively depict the tissue characteristics of the lesions. Ultrasonography can also be performed immediately and repeatedly, and therefore it can support a clinical diagnosis. Color Doppler ultrasonography can depict small and slow blood-flows[4–5]. Ultrasonographic imaging features of various lesions in the head and neck regions have been reported with reference to the histopathological features, whereas there have been only a few reports concerning the ultrasonographic imaging features of tumorous lesions in the floor of the mouth[6–14].

In the present study, the ultrasonographic imaging characteristics of tumorous lesions in the floor of the mouth are presented and the differential diagnoses are discussed.

Materials and Methods

1. Patients

We reviewed ultrasonograms of tumorous lesions of the floor of the mouth in an imaging database between

Table 1 Ultrasonographic imaging features of patients with tumorous lesions in the floor of the mouth

Patient No.	Age	Sex	Pathological diagnosis	Scanning method *	Ultrasonographic imaging features		
					Boundary	Homogeneity	Echogeneity
1	65	Male	Metastatic carcinoma to lingual lymph node (Squamous cell carcinoma)	Submental	Relatively well-defined	Relatively heterogeneous	Hypoechoic
2	4	Male	Lymphangioma	Submental	Well-defined	Homogeneous	Anechoic with septum
3	37	Female	Schwannoma (Antoni type A)	Submental	Well-defined	Homogeneous	Echogenic
4	18	Male	Ranula	Submental	Well-defined	Homogeneous	Hypoechoic with internal echo
5	11	Female	Dermoid cyst	Intraoral	Well-defined	Relatively homogeneous	Echogenic with hypoechoic spots

Patient No.	Age	Sex	Ultrasonographic imaging features	
			Posterior echo	Color Doppler signal
1	65	Male	No enhancement	Peripheral color
2	4	Male	Enhancement	No color
3	37	Female	Enhancement	Internal color
4	18	Male	Enhancement	No color
5	11	Female	Enhancement	No color

* Submental, ultrasonography via submental region; Intraoral, ultrasonography with intraoral probe

1999 and 2005. The diagnosis was based on the histopathological evidence. Five patients had the following diseases (Table 1): Metastasis to the median lingual lymph node in a patient with lingual squamous cell carcinoma, lymphangioma, Schwannoma, ranula and dermoid cyst. The patients (3 males and 2 females) ranged in age from 4 to 65 years (median 18.0 years).

2. Ultrasonographic examinations

Ultrasonographic examination was performed using a Logiq 700 (GE Yokogawa Medical Systems, Tokyo, Japan) equipped with a 12 MHz bandwidth linear active matrix transducer (ranging from 6 to 14 MHz) and a 5-11 MHz bandwidth linear intraoral probe. Images were obtained by approach via the submental surface or direct intraoral scan, under the following conditions: the focal range was set to a multi focus from 0.5 to 2.0 cm; the image depth was set to 4 cm; and the echo gain and dynamic range were 42 dB and 72. Color Doppler ultrasonography was performed under 50 dB of color gain. The wall filter and pulse-repetition frequency were adjusted to prevent artifacts.

3. CT examination

CT examination was performed with a Somatom ART (Siemens AG, Erlangen, Germany) or HiSpeedNX/Ipro (GE Medical Systems, Tokyo, Japan). Patients were scanned in the supine position with a section thickness of 2 or 3 mm and scan plane parallel to the occlusal plane or inferior margin of the mandible. Cases 1 and 3 underwent intravenous contrast enhancement (rapid drip of 100 ml, iopamidol [Iopamiron 300], Schering, Berlin, Germany).

4. Evaluation of imaging features

The boundary, internal homogeneity and echogenicity of the lesions were evaluated by three radiologists. The existence of the posterior echo enhancement and the appearance of the color Doppler signal were also evaluated. When a consensus at the initial evaluation was not reached, the final decision was made by consensus after discussion.

5. Evaluation of histological features

The histopathological specimens (HE) were evaluated by two oral pathologists, and consensus was reached by discussion.

6. Review of the literature on imaging characteristics

In order to collect the imaging features of tumorous diseases in the floor of the mouth, the literature was searched by the identifying key words "Carcinoma or Cancer or Sarcoma or Tumor or Cyst", "Floor of mouth or Sublingual" and "Ultrasonography" in the MEDLINE database (Pub Med) between 1996 and 2005. We agreed on the following inclusion / exclusion criteria:

1. Only studies of humans were included.
2. Only studies written in English were included.
3. Original articles and case reports were included.
4. Review articles that did not present individual case information were excluded.
5. Studies in which the authors neither showed images nor described image findings were also excluded.

Results

Case presentation

The imaging features of our patients are summarized in Table 1.

Case 1

A 65-year-old male underwent tumor excision of the left margin of the tongue 3.2 years ago. The pathological diagnosis was a well-differentiated squamous cell carcinoma of the tongue (T1N0M0). He had delayed metastasis to the bilateral cervical lymph nodes, and underwent radical neck dissection in the right side 14 months ago and functional neck dissection in the left side 7 months ago. He suffered from hoarseness for 4 months. He had a hard mass in the submental region for 1 month. CT images showed a relatively well-defined rim-enhanced mass in the median region of the floor of the mouth. Ultrasonographic images showed a relatively well-defined hypoechoic mass without posterior echo enhancement. Color Doppler images showed peripheral vascularity (Fig. 1). A mass was identified as metastasis to the median lingual lymph node.

Case 2

A 4-year-old boy had a mass with slight pain in the floor of the mouth for 3.3 years. CT images showed a low density mass with CT number of 15 HU (Hounsfield units) in the floor of the mouth and the submental region. Ultrasonographic images showed a well-defined

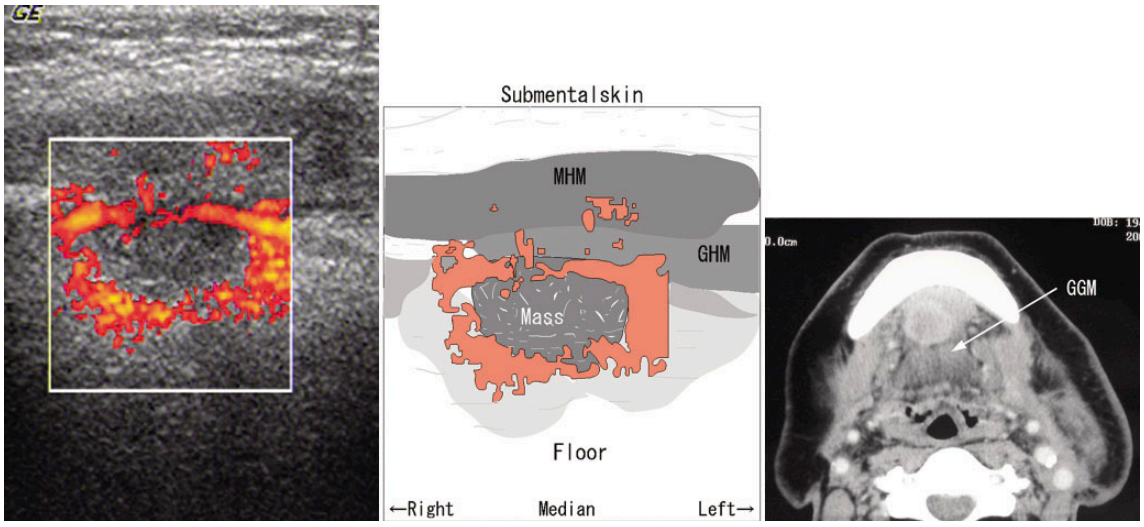

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Fig. 1 Images of a 65-year-old male with a metastatic median lingual lymph node of a well-differentiated squamous cell carcinoma of the tongue (Case 1)
A. A color Doppler ultrasonographic image showing a relatively well-defined heterogeneous hypoechoic mass with the peripheral color signal in the median floor of the mouth. This image was obtained by approach via the submental surface.
B. A schema explaining the anatomical features in Fig. 1 A.
Floor, floor of mouth; MHM, mylohyoid muscle; GHM, geniohyoid muscle
C. A CT image showing a relatively well-defined rim-enhanced mass after administration of the contrast media. GGM, genioglossus muscle (arrow).

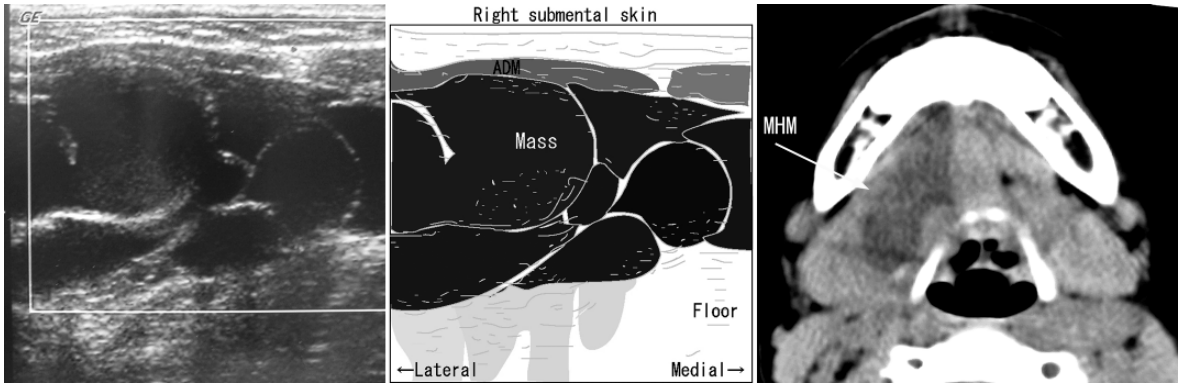

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Fig. 2 Images of a 4-year-old boy with a lymphangioma (Case 2)
A. A color Doppler ultrasonographic image showing a well-defined anechoic to hypoechoic mass with the septum structure in the floor of the mouth and the submental region. This image was obtained by approach via the submental surface. There was posterior echo enhancement but no color signal.
B. A schema explaining the anatomical features in Fig. 2 A.
Floor, floor of mouth; ADM, anterior belly of digastric muscle
C. A CT image showing a low density mass with a CT number of 15 Hounsfield units. MHM, mylohyoid muscle (arrow).

anechoic to hypoechoic mass with the septum structure. Posterior echo enhancement was also observed. There was no color signal on color Doppler ultrasonography (Fig. 2). The pathological diagnosis was a lymphangioma.

Case 3

A 37-year-old female had a painless 25 × 20 mm hard

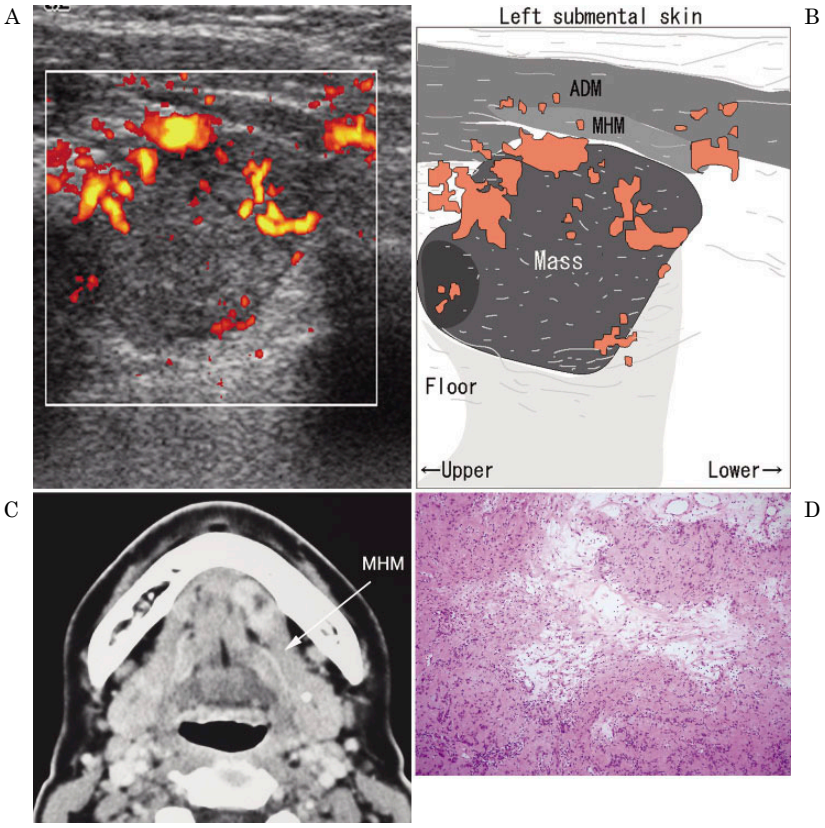

Fig. 3 Images of a 37-year-old female with a Schwannoma (Case 3)
A. A color Doppler ultrasonographic image showing a well-defined homogeneous echogenic mass with the internal color signal in the left floor of the mouth. Posterior echo enhancement was also observed. This image was obtained by approach via the submental surface.
B. A schema explaining the anatomical features in Fig. 3 A. Floor, floor of mouth; ADM, anterior belly of digastric muscle; MHM, mylohyoid muscle
C. A CT image showing a well-defined remarkablely enhanced mass except for the central region. MHM, mylohyoid muscle (arrow).
D. A histopathological specimen showing the predominance of Antoni type A with paling arrangement of spindle-shaped cells. In the central region of the tumor (the center to upper part of this figure), there are myxoid tissues and some vessels. (HE ×50)

mass in the left side of the floor of the mouth for 3 months. CT showed a well-defined, remarkably enhanced mass, except for the central region. Ultrasonographic images showed a well-defined homogeneous echogenic mass with posterior echo enhancement. Color Doppler images showed the internal color signal. A histopathological specimen showed the predominance of Antoni type A with a paling arrangement of spindle-shaped cells. In the central region of the tumor, there were myxoid tissues and some vessels (Fig. 3). The parent nerve could not be confirmed from the operating record.

Case 4

An 18-year-old male had a painless soft mass in the left sublingual region for 1 year. The mass was slowly enlarging. CT showed a well-defined low density mass above the mylohyoid muscle. Ultrasonographic images showed a well-defined homogeneous mass with posterior echo enhancement. Color Doppler images showed no signal (Fig. 4). The pathological diagnosis was a ranula, including mucus.

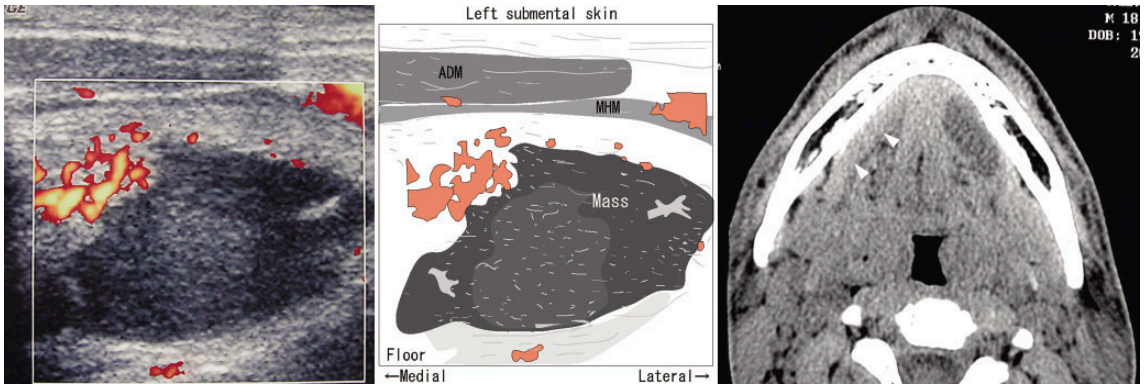

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Fig. 4 Images of an 18-year-old male with a ranula (Case 4)
A. A color Doppler ultrasonographic image showing a well-defined homogeneous mass without a color signal in the left floor of the mouth. Posterior echo enhancement was also observed. This image was obtained by approach via the submental surface.
B. A schema explaining the anatomical features in Fig. 4 A.
Floor, floor of mouth; ADM, anterior belly of digastric muscle; MHM, mylohyoid muscle
C. A CT image showing a well-defined low density mass above the mylohyoid muscle. Arrowheads show the opposite mylohyoid muscle (MHM).

Case 5

An 11-year-old girl did not realize that she had a mass in the median floor of the mouth until CT examination. CT showed a well-defined low density mass. Ultrasonographic images showed a well-defined coarse echogenic mass with posterior echo enhancement. Color Doppler images showed no signal. A histopathological specimen showed dermoid cyst. The cyst was lined by stratified squamous epithelium with hyperorthokeratosis, and included abundant keratin and a small number of sebaceous glands (Fig. 5).

Review of the literature on ultrasonographic imaging characteristics

Nine reports[6–14] met the criteria. According to the results of this search, ultrasonographic imaging features were described for malignant tumors (squamous cell carcinoma), benign tumors (hemangioma, lipoma) and cyst (ranula, epidermoid and dermoid cyst). Table 2 shows a summary of ultrasonographic imaging features of the tumorous lesions in the floor of the mouth.

Ultrasonographic images of the squamous cell carcinoma showed a heterogeneous hypoechoic mass because of central necrosis[6–7]. Hemangioma showed a hypervascular mass and the cavernous type in particular was often accompanied by hyperechoic structures with posterior shadowing (phleboliths)[8–9]. Lipoma showed a well-defined homogeneous hypoechoic mass with the surrounding echogenic line[10]. Ranula showed a well-defined hypoechoic mass without a color signal[11–12]. Dermoid cyst showed a well-defined coarse echogenic to hypoechoic mass, varying in echogenicity and homogeneity according to the ratio of keratin and lipid[13–14].

Discussion

The floor of the mouth includes various tissues, such as salivary glands, hypoglossal and lingual nerves and vessels, lingual lymph nodes, fatty tissues, and so on. Therefore, tumors of the floor of the mouth originate in these tissues[2]. When a mucous membrane covering up a tumor is normal, diagnosis of the tumor becomes difficult. Imaging may provide some information for the diagnosis, because of its ability to demonstrate the extent and contents of the tumor. CT and MR images can show the extent, while ultrasonography will reveal the contents of the tumor.

Ultrasonography is extremely sensitive for the detection of tumors owing to its multiplanar capability[9]. Color Doppler ultrasonography can assess well the characteristics of tumors such as vascularity: hypervascularized tumors are regarded as indicative of malignancy[15]. Ultrasonography usually accesses the floor of the mouth via the submental region. However, ultrasonography equipped with a high frequency band probe often cannot often depict deeply situated tumors[9]. This problem can be solved by using intraoral ultrasonogra-

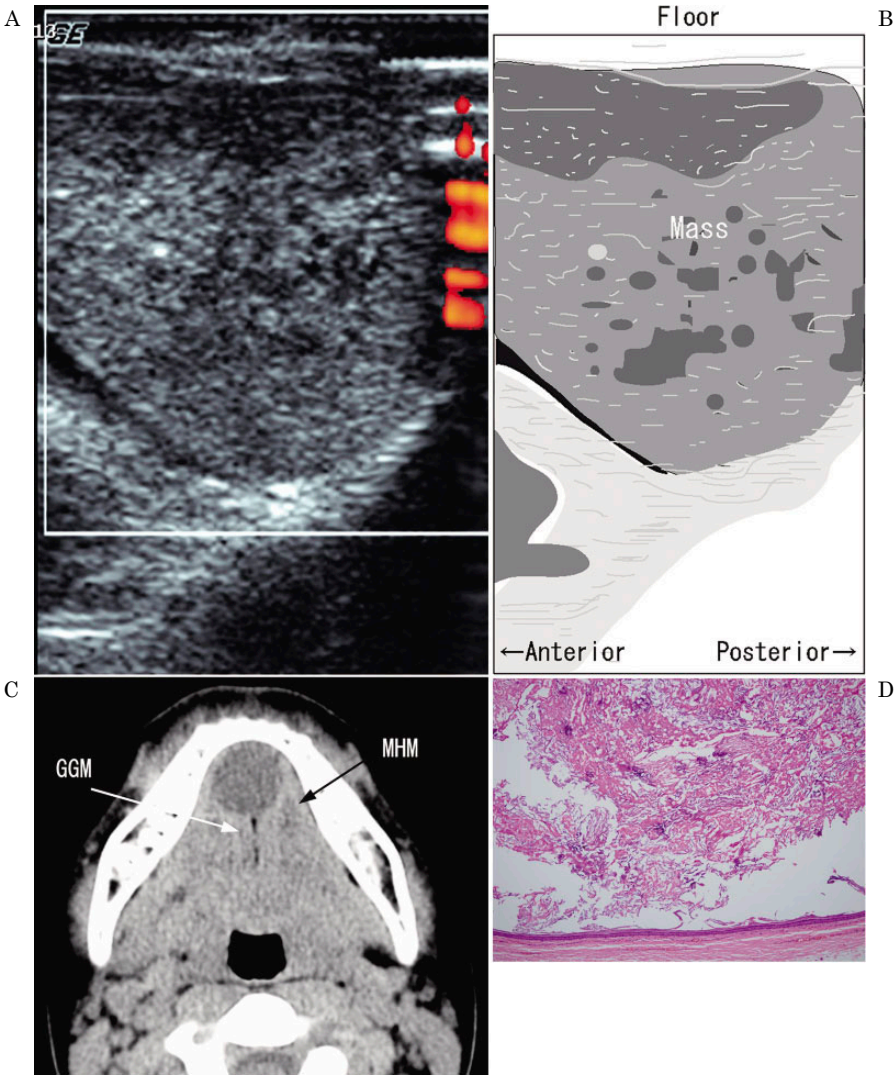

Fig. 5 Images of an 11-year-old girl with a dermoid cyst (Case 5)
A. A color Doppler ultrasonographic image showing a well-defined coarse echogenic mass without color signal in the median floor of the mouth. Posterior echo enhancement was also observed. This image was obtained by direct intraoral scan.
B. A schema explaining the anatomical features in Fig. 5 A. Floor, floor of mouth
C. A CT image showing a well-defined low density mass.
GGM, genioglossus muscle (white arrow); MHM, mylohyoid muscle (black arrow).
D. A histopathological specimen showing a cyst lined by stratified squamous epithelium with hyperorthokeratosis. The cyst includes abundant keratin and a small number of sebaceous glands (HE ×50).

phy, which has recently been used to assess various conditions in the mouth[6,16-18].

Squamous cell carcinoma can be easily diagnosed by ocular inspection, whereas imaging assists the evaluation of the size and extent of the tumor[6]. Squamous cell carcinoma has an infiltrating spread to the surrounding structures[19], and therefore it is sometimes difficult to decide the accurate extent of the tumors on images. Ultrasonography demonstrates these as relatively well-defined hypoechoic masses, spreading to fill up the space between structures[6,7].

The lingual lymph node has rarely been reported to appear between the lingual structure and cervical lymph nodes[20,21]. Groups of lateral lingual lymph nodes

Table 2 Summary of ultrasonographic imaging features of tumorous lesions in the floor of the mouth through review of the literature

Tumorous lesions	Ultrasonographic imaging features				Reference
	Boundary	Homogeneity	Echogeneity	Posterior echo	Color Doppler signal	
Squamous cell carcinoma	Relatively well-defined	Heterogeneous	Hypoechoic	No enhancement	(Not mentioned)	Shintani[6] Lenz[7]
Hemangioma (Capillary or Cavernous)	Relatively well-defined Lobulated	Heterogeneous	Hyperechoic to hypoechoic with phlebolith	No enhancement	Hypervascular	Cankaya[8] Gritzmann[9]
Lipoma	Well-defined	Homogeneous	Hypoechoic with echogenic line	No enhancement	(Not mentioned)	Zhong[10]
Ranula	Well-defined	Relatively homogeneous	Hypoechoic with internal echo	Enhancement	No color	Hidaka[11] Garcia[12]
Dermoid cyst Epidermoid cyst Teratoid cyst	Well-defined	Homogeneous to heterogeneous	Echogenic to hypoechoic	Enhancement	No color	Longo[13] Babuccu[14]

are located either on the lateral aspect of the genioglossus muscle or on the hyoglossus muscle along the lingual artery and vein, while groups of the median lingual lymph nodes are located on the central collecting vessels that run towards the floor of the tongue along the lingual septum[20, 21]. Our case 1 was equivalent to the latter. The location of the tumor was mainly confirmed by CT, whereas ultrasonography clearly showed the positional relationship between the tumor and genioglossus muscle.

Tumors originating in the sublingual and minor salivary gland have often been reported[3, 19]. Most of these were malignant tumors[3]. Although we could not find any reports concerning the ultrasonographic features of salivary gland tumors in the floor of the mouth, parotid and submandibular gland tumors have frequently been reported[9, 22–25]. According to those reports, ultrasonography of the most malignant tumors, such as adenoid cystic carcinoma and mucoepidermoid carcinoma, shows the heterogeneous hypoechoic mass with the bottom echo. The heterogeneity in the malignant tumors is caused by a tendency to be accompanied with hemorrhage, cystic degeneration, calcification, and so on[24–26]. The tumors with high vascularization on color Doppler ultrasonographic images are very likely to be malignancies[15, 25].

The ultrasonographic features of malignant lymphomas in the floor of the mouth have not been reported. Non-Hodgkin's lymphoma in the neck was demonstrated as a round, hypoechoic mass or a conglomeration of masses, the so-called 'facet formation' [9, 23, 27]. Color Doppler ultrasonography shows a fairly regular branching

of the intranodal vessels[27].

Hemangiomas in the floor of the mouth are often histologically diagnosed as capillary or cavernous. Ultrasonography of the hemangioma usually shows a heterogeneous mass[5, 8, 9, 27]. It mostly appears as hyperechoic, or sometimes as a hypoechoic mass with a typical lobular pattern, because the echogenicity of hemangiomas varies considerably depending on the number and size of the 'cystic' vascular spaces[9]. Color Doppler ultrasonography can depict high-flow[5, 9, 27]. Another characteristic is the frequent accompanying of phleboliths in cavernous hemangioma[8].

Lymphangioma is characterized by septation and lobulation[27, 28], which was observed in our Case 2. Color Doppler ultrasonography showed no or only a few signals in our case and in Gritzmann's report[27].

The present case 3 was predominantly occupied by an Antoni type A tissue and showed a well-defined homogeneous mass with a whorled echogenic internal architecture. This feature is similar to that of Beaman's report[29]. Other reports mentioned the heterogeneous appearance, due to degeneration and cystic cavitation[30]. This discrepancy may be caused by the difference in the histopathological types. The involved nerves are sometimes observed eccentrically[27, 29-30], which is a characteristic imaging feature for Schwannoma. However, the present case did not show such imaging features and the parent nerve could not be confirmed in the operation. Color Doppler ultrasonography can reveal moderate to significant internal vascularity in tumors[27], as observed in our case.

Lipomas are typically oval, elongated lesions. The echogenicity of lipomas varies depending on the relative proportions of fat and fibrous tissue[27]. Most lipomas are well-defined hypoechoic masses with multiple internal fine echogenic lines or spots[10, 27, 31]. CT is recommended to confirm the fatty content of the tumor.

Ultrasonography of the ranula shows a hypoechoic mass with some internal echoes in the literature[11, 12] and in our case 4. Most ranulas are pseudocysts, derived from the sublingual gland. Ultrasonography clearly showed the relationship between the cyst and the mylohyoid muscles. Color Doppler ultrasonography showed no vascularity[12].

Dysontogenic cysts include epidermoid and dermoid cysts and teratomas[14, 27]. Epidermoid and dermoid cysts rarely occur in the midline of the floor of the mouth or the tongue[27]. Dermoid cysts are often echogenic, owing to the high acoustic impedance of hair, sebum and fluid, but are sometimes hypoechoic[13, 27, 32, 33]. Another report showed the feature of multiple round hypoechoic foci, owing to the islets of keratin[32]. Ultrasonography of our case 5 (dermoid cyst) reflected the scattered abundant keratin and a small number of sebaceous glands. Epidermoid cysts are also coarse homogeneous echogenic or hypoechoic with echogenicity[27, 32]. Color Doppler ultrasonography showed no internal vascularity in the literature[33] or in our case. The presence of mature cartilage is considered a characteristic of teratomas[14].

In the present study, we presented 5 cases of tumorous lesions in the floor of the mouth and summarized the differential diagnosis through reviews of the literature. Ultrasonographic images presented the distinctive features of the lesions, and therefore are considered useful for easier and more accurate diagnosis prior to treatment.

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